APPLICATION OF ALGAE IN AIR POLLUTION CONTROL TECHNIQUE

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

BY

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NATIONAL INSTITUE OF TECHNOLOGY

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UNDER GUIDANCE OF

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CERTIFICATE

This is to certify that the thesis entitled "*application of algae in air pollution control technique*" submitted by Smita Sarojini Bagh Roll no-111ce0027 in partial fulfilment of the requirements for the award of Bachelor of Technology degree in Civil Engineering at National Institute of Technology, Rourkela is an authentic work carried out by her under my supervision and guidance.

To the best of my Knowledge, the matter embodied in this thesis is not been submitted to any other university/institute for any Degree or Diploma

Date: (Prof.K.K.Paul)

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ABSTRACT

Air pollution is creating alarming situation day by day. Various primary and secondary air pollutants are the reasons behind it which are formed by various stimuli. To overcome the threats various control technologies like cyclonic separation, various scrubbers, hydrodynamic separator etc were used. One more method bio-filtration is used which uses living micro or macro organisms to biodegrade waste or harmful constituents. Air pollutants can be removed by the process of bio filtration. Aim of the project is to use algae in air pollution control technique and determine its efficiency when coconut fibres were used as filter bed. Hydrogen sulphide was prepared by Kipp's apparatus. Filter bed of coconut coir was designed. Known concentration of hydrogen sulphide was passed through filter bed and concentration of passed air was measured by iodometric method. The collected algae were spread in filter bed. The known concentration of hydrogen sulphide was then passed through this filter bed consisting algae and passed air's final concentration was again determined. The efficiency of only filter bed was found to be 62.52% and filter bed with algae was 70.66%.Algae can be successfully used in air pollution control technique.

Keywords: Air pollution, Air quality standard, Algae, Coconut fibre bed, Hydrogen sulphide, Kipp's apparatus, Pollutants

CHAPTER 1:

INTRODUCTION

1.1 INTRODUCTION

Air pollution is growing day by day and it threat is becoming a challenge which we need to overcome. Every life form one way or another is getting affected by this threat. Air pollution are caused by various pollutant may it be primary like sulphur dioxide, carbon monoxide, volatile organic compounds, chlorofluorocarbons CFCs etc or secondary like ozone, peroxyacytele nitrate (PAN). Each pollutant has its own threats to us, out of which some creates grave danger to human life. According to IS code 15200-2002 code of safety for hydrogen sulphide, when it exceeds the permissible limit of 10 ppm is fatally poisonous gas which affects respiratory tract, even causes skin irritations and eye itchiness. To check threats by pollutants various methods like absorption, adsorption, bio filtration etc are there. Bio-filtration technique is one of most efficient technique which takes microorganisms in action to treat polluted air. This bio filtration technique has used bacteria and fungi in bio film. We have algae in tremendous quantity and these algae are very much efficient in capturing carbon dioxide and using that in their further growth. Algae’s contribution in Oxygen concentration is very well known and appreciated. So why not to use algae for air pollution control technique? So aim of this project is to use these algae and observe if they can treat polluted air. For that we first need to produce known concentration of any pollutant. Hydrogen sulphide can be produced by Kipp’s apparatus using sulphuric acid and ferrous sulphate (John wiley & sons, 1900). To know the concentration of produced hydrogen sulphide iodometric back titration method can be done. The bio filter bed can be produced using various material like wood chips, peat, plastic media of different shapes, glass etc. In this method, coconut fibre has been used to prepare filter bed. The algae were collected from local ponds and used for filtration.

CHAPTER 2

LITERATURE REVIEW

2.1 LITERATURE REVIEW

In this section the literature meeting the goal of study i.e. application of algae in air pollution control technique is reviewed. Algae create more than 70% of oxygen by photosynthesis. Algae seem to have the capacity to ingest carbon dioxide, nitrogen dioxide and sulphur dioxide. Moreover carbon dioxide escalates their growth to further extent. Algae have more photosynthetic efficiency than plants and herbs so they are more able to catch carbon dioxide. Various plants discharges high rate of carbon dioxide like coal terminated plants. In this cases if we can incorporate algae in filtration media than we will be in side of benefit.

Studying the remarks by (Munoz et al, 2009) wastewater can be used as microalgae supplement and algal biomass could get the opportunity to be, soon, a budgetary and suitable material for specific removal of heavy metals from waste water.

Vent gasses from various plants are culprit for creating more than 7% of the aggregate world CO_2 generation mechanical fumes gasses contains up to 15% CO_2.

(Cheng et al. (2006)) concentrated on carbon dioxide expulsion from air by microalgae refined in a layer photograph bioreactor. He found that the photosynthetic CO_2 obsession was unequivocally subject to the amassing of CO_2 consistently gave amid the algal development.

In light of study by Keiun Kodo, Yasumasa Kodo, Makoto Tsuruoka(1998) a system for cleansing a sullied air by using green growth development, for instance, Spirulina is fit for decreasing carbon dioxide (CO_2), nitrogen oxide (NOx) and/or sulfur oxide (SOx) in the dirtied air and creating oxygen. That is, this structure includes a general public tank stacked with a general public fluid including the green development, an air supply unit for convincing the polluted air into the lifestyle fluid to separate carbon dioxide and nitrogen oxide and/or sulphur oxide in the lifestyle fluid, and a lighting unit for radiating a light to the lifestyle fluid. By exuding the light to the lifestyle fluid in the region of carbon dioxide, photosynthesis of the green development is raised to change over carbon dioxide into oxygen. Besides, the green development uses the nitrogen oxide and/or sulphur oxide as a supplement in the midst of the photosynthesis. In this way, the present system can adequately refine the debased air to make a cleaner air, which is rich in oxygen. (Fun et. al., 2011) prepared bio-powers from green growth extraordinarily biodiesel. The quick advantage of green growth is growing step by step

According to National Air Quality Standards, 2009 .Air sample collected should be compared with the standard:

Table 1; Ambient air quality standard

pollutant	Time weighted	Concentration in Ambient air		Methods of measurement
		Industrial area Residential area	Sensitive area	
Sulphur dioxide	annual	80 µg/m^3	20	UV fluorescence
Nitrogen dioxide	annual	40	30	Chemiluminescence
PM_{10}	annual	60	60	Gravimetric,beta attenuation
ozone	8 hours	100	100	UV photometric, chemiluminescence
lead	annual	0.5	0.5	XRF using Teflon filter
Carbon monoxide	8hours	2	2	IR spectroscopy

(Source: Central Pollution Control Board, 2006)

Following code of safety of hydrogen sulphide it is highly hazardous. It can cause fire and explosion

Table 2: Code of safety of hydrogen sulphide

Sl.no	Concentration(ppm)	Effects	Measures
1	10	Eye irritations if exposed more than 4 hours	Maximum Permissible limit
2	50-250	Eye irritations, respiratory and lungs problem	Protective measures requires
3	100-400	Highly risky. Possible death	Protection needed to avoid death
4	500-1000	Immediate unconsciousness	-do-

(Source: IS 15200-2002 code of safety)

OBJECTIVE

The objective of the present study is to design the coconut filter bed in treating hydrogen sulphide gas. Also, to treat hydrogen sulphide gas by coconut fibre bed with wild algae.

CHAPTER 3

METHODOLGY

3.1 SAMPLE COLLECTION

Collection of wild algae:

- Collection of algae: plastic bottle can be taken which was first de-chlorinated. Using the bottle algae was collected along with water. Algae were allowed to settle down when left overnight.
- The flasks petridishes all which is to be used when working with algae were sterilised using autoclave at 121^{o}C for 15 min at 15 psi. And were allowed to cool (Atlas, 2010)
- The collected algae was sterilised too. And antifungal was then added about 1gm.
- The collected algae can be further divided to number of algal broths were nutrients can be provide for further growth of algae. The broth can be left for incubation in room temperature.

Figure A: algae collected in bottle are allowed to settle down.

3.2Design of filter bed:

Coconut fibre is collected. The fibre (10-15cm) is given a proper shape when compressed.

Figure B: coconut fibre filter bed of surface area 45.83 cm^2

Table 3: Size of filter bed

Filter bed no	surface area(cm^2)	Thickness(cm)
1	153.15	0.5
2	45.83	2.2
3	38.48	1.8
4	12.56	0.5

3.3 Filter bed with algae:

- Filter bed of coconut fibre was taken.
- Filter bed which is wetted with nutrient (water from where algae is collected) is taken in laminar air flow chamber.
- Algae are placed on filter bed.(Shpigel,2007)

Figure C: Filter bed with algae

3.4 Production of Hydrogen sulphide:

- Hydrogen sulphide (H_2S): Kipp's mechanical assembly was utilized. Strong iron sulphide was put in center chamber; the corrosive sulphuric acid is put into the top barrel. Center barrel has tube joined to it with stopcock to draw advanced gas. At the point when stopcock is shut weight creates which sends back corrosive to top chamber and response stops as corrosive acid was no longer in contact with solid ferrous sulphide.

- In Kipp's device different contaminations like methane (from aluminium carbide and tepid water), Nitric oxide (from copper turnings and weakened nitric corrosive), Carbon dioxide (from bits of marble calcium carbonate and hydrochloric corrosive) can be created

Reagents used:

- Sulphuric acid
- Solid ferrous sulphate solution

Apparatus used:

- Kipp's apparatus
- Flask
- Pipette

Procedure:

- Ferrous sulphate is put in middle chamber. 2 N H_2SO_4 is used. To make 2N H_2SO_4 27.17 ml of pure H_2SO_4 is diluted to 500 ml.(Anil Kumar De, 2007)
- Stop cock is put in open condition then acid from bottom chamber which have travelled from top chamber goes to middle chamber and react within and H_2S is generated
- And then stopcock is put in closed condition which creates pressure and stops the reaction. And no longer is H_2S produced.

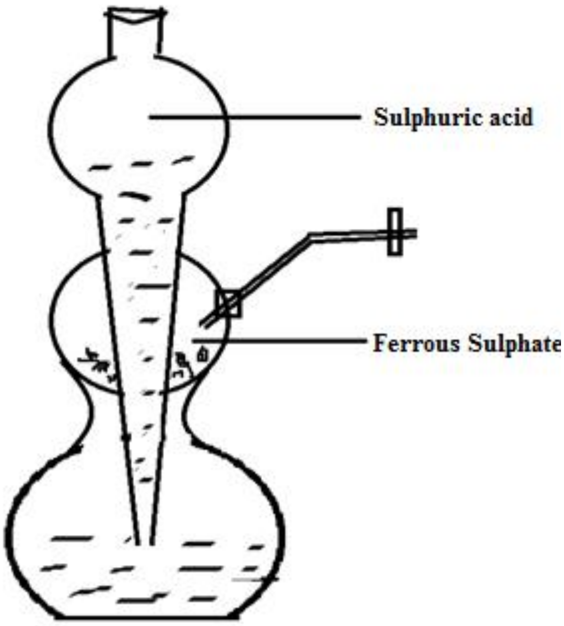

Figure D: Kipp's apparatus

3.5 Determination of concentration of pollutant H_2S

Iodometric back titration method was used. [IS 11255 (part 4)-2006]

Reagents used:

- Cadmium chloride solution: it was prepared adding 10g $CdCl_2$ in 450 ml water. And 10 ml 0.5N sodium hydroxide solution is added
- Iodine solution(0.025N):20-25g potassium iodide was added in little water. Then 3.2 g iodine is added and was allowed to dissolve.the sample was diluted to 1000ml.
- Standard sodium thiosulphate solution (0.0250N): 6.205g sodium thiosulphate pentahydrate ($Na_2S_2O_3.5H_2O$) and 0.4 g solid sodium hydroxide is added. Then the sample is diluted to 1000ml.
- Starch indicator: 2g soluble starch and 0.2 g salicylic acid is taken.these are added in 100ml hot distilled water.

Procedure:

- Flasks containing 30 ml absorber i.e. cadmium chloride solution were taken
- H2s was passed through these absorber
- Sample was titrated with excess of potassium iodine solution. Reading is noted as A when yellow colour is achieved. End point is checked by HCl.
- After 10 min it was back titrated with 0.025N sodium thiosulphate solution.colour disappeared and starch solution is used as indicator.
- Observations were noted in table 3.
- Hydrogen sulphide concentration is measured by equation 1.

$$H_2S\ concentration\ (ppm) = \frac{12400*A*B}{c} \quad \ldots\ldots\ (1)$$

Where

A=Volume of iodine solution
B=Normality of iodine solution
C=volume of sample taken

3.6 Pollutant removal by Filter bed:

- Initial concentration of H_2S was found from Table 4.

- Air passed through filter bed was then passed through absorbing solution to check the concentration of H_2S
- The Iodometric method is used again to find the concentration of hydrogen sulphide.
- The readings were noted in table 5.
- Removal efficiency of filter bed found from table 7.

3.7 Pollutant removal by filter bed with algae

- Filter bed which is wetted with nutrient(water from where algae is collected) is taken in laminar air flow chamber
- There freshly collected algae is placed in filter bed.
- H_2S is passed through the filter media i.e.flter bed with wild algae.
- It was left for 1 hour.
- Then the gas passed through this media is collected and passed through absorbing solution i.e. cadmium sulphate solution.
- And iodometric method is followed to find the concentration of hydrogen sulphide passed through filter media.
- The final concentration of H_2S was found from table 6.
- Removal efficiency by filter bed with algae is calculated from table 9.

Pollutant removal efficiency calculation:

Removal efficiency is found out by equation 2 =

$$\eta\ (\%) = \frac{initial\ conc - final\ conc}{initial\ conc} * 100 \qquad \text{........... (2)}$$

CHAPTER4:

OBSERVATIONS

The concentration of produced hydrogen sulphide was determined by iodometric back titration method the readings were tabulated below in table 4.

Table 4:Determination of initial concentration of H_2S

No of observation	Initial burette reading(ml)	Final burette reading(ml)	Concentration of H_2S(ppm)	Average concentration
1	0	2.4	24.80	
2	2.4	4.8	24.80	24.81 ppm
3	4.9	7.8	25.83	

The hydrogen sulphide of 24.81 ppm was passed through filter beds without algae. And the reading of iodometric back titration was noted down in table 5.

Table 5: concentration of H_2S after passing through filter bed only

Observation no	Filter bed no	Initial burette reading(ml	Final burette reading(ml)	Concentration of H_2S(ppm)
1	1	20	21	10.33
2	3	22	23	10.33
3	2	30.3	31	7.23

Filter bed with were taken and the known concentration of hydrogen sulphide was passed through it. And hydrogen sulphide so passed concentration was determined using iodometric back titration method and readings were tabulated in table 6.

Table 6: Concentration of H_2S after passing through filter bed with algae

Observation no	Initial burette reading (ml)	Final burette reading (ml)	H_2S concentration(ppm)
1	31	31.8	8.26
2	31.8	32.7	9.3

Removal efficiency of filter beds and filter beds with algae were tabulated in table 7 and table 8, respectively.

Table 7: Removal efficiency by only filter bed without algae

Filter bed	Initial concentration (ppm)	Final concentration (ppm)	H_2s removed (ppm)	Removal (%)
1	24.81	10.33	14.48	58.36
2	24.81	7.23	17.58	70.85
3	24.81	10.33	14.48	58.36

Removal efficiency=62.52%

Table 8: Efficiency of filter bed with algae in removal of air pollutant H_2S

Filter bed	Initial H_2S concentration(ppm)	Final H_2S Concentration(ppm)	H_2s removed (ppm)	Removal efficiency (%)
1	24.81	8.26	16.55	66.71
2	24.81	6.3	18.51	74.61

Removal efficiency = 70.66 %

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Results and Discussion

From the above procedure initial concentration of hydrogen sulphide gas was found to be 24.81ppm which is exceeding the permissible limit prescribed by code of safety for hydrogen sulphide gas IS 15200-2002. After passing the hydrogen sulphide through filter bed of coconut fibre the final concentration of hydrogen sulphide was determined. The final concentration of hydrogen sulphide passed through 1st filter bed of 153.15 cm^2 and thickness 0.5 cm was found to be 10.33 ppm. And hydrogen sulphide passed through 2nd filter bed of 45.83 cm^2 and thickness 2.2 cm was 7.23 ppm. The 1st filter bed of coconut fibre was 12.5% less efficient than 2nd filter bed in removing hydrogen sulphide gas. In average filter bed of coconut fibre was 62.52% efficient in removing hydrogen sulphide gas.

The 1st and 2nd bed with algae removed 16.55 ppm and 18.51 ppm of hydrogen sulphide gas respectively. In this case 2nd filter bed was 7.9% more efficient in removing hydrogen sulphide. In average removal efficiency of filter bed with algae was found 70.66%. The produced hydrogen sulphide's concentration was then brought down to 6.3ppm by 2nd filter bed which in safe range (IS 15200-2002) . In experimentation process maintaining humidity is a challenge which can be overcome if water can be provided.

CHAPTER 5

CONCLUSION

CONCLUSION

The concentration of hydrogen sulphide gas produced was 24.81 ppm which was in toxic range (IS 15200-2002) and hence, an attempt has been made to reduce its concentration within permissible limit after passing through filter bed. The 2nd filter bed with greater thickness has been found to be more efficient in removing hydrogen sulphide gas. It showed that when filter bed is having more volume it is able to remove better. So, depending upon the required concentration, size of filter bed can be varied and can be used widely. Algae when incorporated in filter bed the efficiency further increases. The efficiency of filter bed with algae was found to be 70.66% whereas, without algae it was 62.52%. Thus, algae can be successfully be used in air pollution control technique. This technique can be used in larger area too to treat more air pollutants in large scale.

CHAPTER 7

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